Alternate Energy Systems, Inc.

A Corporation devoted to Energy Oriented Needs

GraviBlend®-3P Portable Gravitometer

User Manual

Generic Version April 2012

Revision NONE

Alternate Energy Systems, Inc. • 210 Prospect Park • Peachtree City, GA 30269, USA
Phone (770) 487-8596 • Fax (770) 631-4306 • e-mail: info@altenergy.com • http://www.altenergy.com

GraviBlend-3P_Manual_Generic_12Apr12.doc Printed 4/13/2012 7:22:00 AM

Revision Log:

This is a generic version of a standard GB-3P manual. It is intended for information only and does not necessarily represent the configuration of a specific instrument.

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User Manual for Portable Gravitometer GraviBlend®-3P

The GraviBlend®-3P (GB-3P) is the portable version of the successful GraviBlend®-3 series of stationary gravitometers. While the stationary gravitometers were specifically designed for use in LP/Air blending systems, the GB-3P offers functions that are most useful for service and maintenance personnel.

A. Main Instrument Functions

Gravitometer	Measure any non-corrosive gas with a specific gravity (SG) between 0.2 and 2.2 (Air = 1) and display the result with a resolution of 0.001.
LP Ratio Detect	Measure the SG of LPG Vapor and determine the Propane/Butane Ratio.
SNG Mode	Measure the SG of an LPG/Air blend and display Specific Gravity, Heating Value, and Wobbe Index.
TrendLine	Record the SG value and recall the data on a graphic TrendLine screen.
US and SI Units	Heating Value and Wobbe Index on all screens are displayed in standard US Units (BTU/cuft) and in SI Units (kcal/m^3).
Wobbe Index	Enter the properties of a fuel gas (i.e. NatGas), and display its Wobbe Index, and the properties of an LP-based replacement gas (i.e. Propane/Air).

B. Overview

All Functions and System Parameters of this gravitometer are controlled by an Electronic Signal Processor (ESP). The ESP communicates with an Electronic Operator Interface (EOI) with high-resolution (800 x 480) color LCD display and touch screen.

The EOI has a number of screens with soft keys, numeric display fields, text message fields, and so on. The layout of each screen changes in response to the requirements of the task at hand, and as a result of changes of the instrument status, and/or operator input.

The following sections describe the functions of the ESP and the EOI from the viewpoint of the user through descriptions of the functions of the display elements on each screen.

The general principle of the gravitometer is described in the product brochure. A brief overview on how to connect the gravitometer to the sample gas line is provided in Appendix C.

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1. Electronic Operator Interface (EOI)

The EOI has a high-resolution color LCD display with 800 x 480 pixels and touch screen. It can display several lines of text and/or graphics and has a backlight illumination for improved readability.

When power is first applied, the instrument is in "Gravitometer Mode" and the display shows the Specific Gravity (SG) of the connected gas. This screen also provides access to the "Advanced Features", and access to two screens that show a graphic representation of the SG TrendLine.

2. Operating Mode: Basic Gravitometer

The Gravitometer Mode is the default operating mode after power-up. The SG of the gas that is currently present in the measuring chamber of the density cell is displayed in large numbers with a resolution of 0.001.

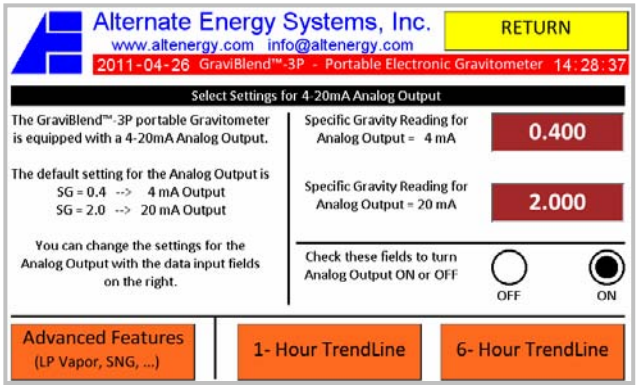
The measuring range of the density cell is 0.2 … 2.2 (Air = 1).

2.1 Analog Output

Analog Output

The GB-3P is equipped with an internally-powered 4-20 mA analog output. In operating mode "Basic Gravitometer", the output is assigned to represent the Specific Gravity. The output can be turned ON or OFF, and the range-assignment of the output can be established or changed, by pressing the "Analog Output" button in the upper-right area of this screen.

This opens the Analog Output Setup Screen. The screen has two numeric data input fields on the right, and two radio-buttons for ON/OFF below them.


Alternate Energy Systems, Inc.
www.altenergy.com info@altenergy.com
RETURN
2011-04-26 GraviBlend™-3P - Portable Electronic Gravitometer 14:28:37
Select Settings for 4-20mA Analog Output
The GraviBlend™-3P portable Gravitometer is equipped with a 4-20mA Analog Output.
The default setting for the Analog Output is
SG = 0.4 --> 4 mA Output
SG = 2.0 --> 20 mA Output
You can change the settings for the Analog Output with the data input fields on the right.
Specific Gravity Reading for Analog Output = 4 mA
0.400
Specific Gravity Reading for Analog Output = 20 mA
2.000
Check these fields to turn Analog Output ON or OFF
OFF
ON
Advanced Features
(LP Vapor, SNG, ...)
1- Hour TrendLine
6- Hour TrendLine

In the example shown on the right, the Analog Output is set to 4mA at SG=0.4 and 20mA at SG=2.0.

To change a setting, simply press the display field. This opens a 10-key keypad. Enter the new value and press ENTER.

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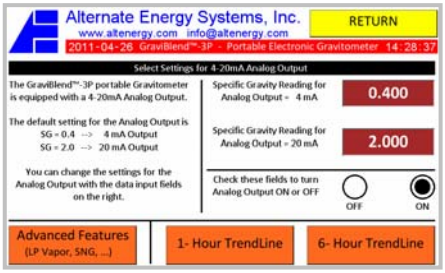
2.1.1 Data Entry Procedure

Press a numeric display field to open the 10-key pad.


Alternate Energy Systems, Inc.
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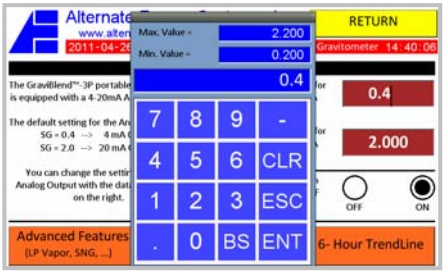
RETURN
Select Settings for 4-20mA Analog Output
Specific Gravity Reading for Analog Output = 4 mA
0.400
Specific Gravity Reading for Analog Output = 20 mA
2.000
Check these fields to turn Analog Output ON or OFF
OFF
ON
Advanced Features (LP Vapor, SNG, ...)
1- Hour TrendLine
6- Hour TrendLine

Enter the new value.



Press the ENT (Enter) key to accept the input, or the CLR (Clear) key to erase your input, or the ESC (Escape) key to cancel your input.

CAUTION:
The 4mA and 20mA equivalents can be freely assigned to any reading over the entire range of the density cell. Apply caution when setting the output range!

2.2 TrendLine Display

1- Hour TrendLine

6- Hour TrendLine

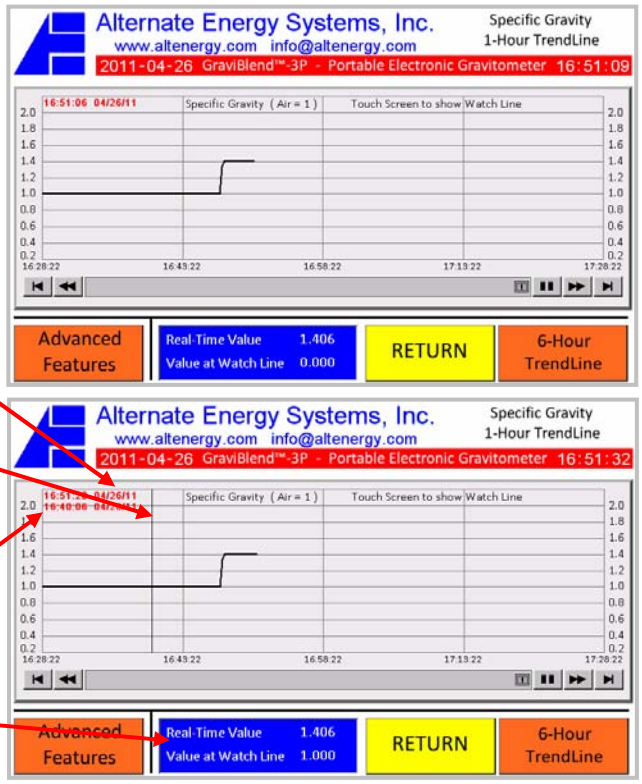
When in "Basic Gravitometer" mode, the system monitors the Specific Gravity values and stores them every 15 seconds in a datalog file. The stored data can be recalled and graphically displayed by pressing the "1-Hour TrendLine" or "6-Hour TrendLine" buttons.

The bottom of the TrendLine Display has a time stamp. Current Time and Date are also shown in the upper-left area of the graphic.

If you touch the screen anywhere in the TrendLine Display, a vertical line appears.

The Time and Date of the position of the vertical line are displayed below the realtime Time and Date display.

The process values that were recorded at that time and date are shown in the lower-center area of the screen.



NOTE:
You can navigate the trend line graphics with the scroll buttons at the bottom of the screen.

NOTE:
The EOI stores up to 96 hours of data. After 96 hours of data are recorded, the oldest data is discarded and replaced by newer data.

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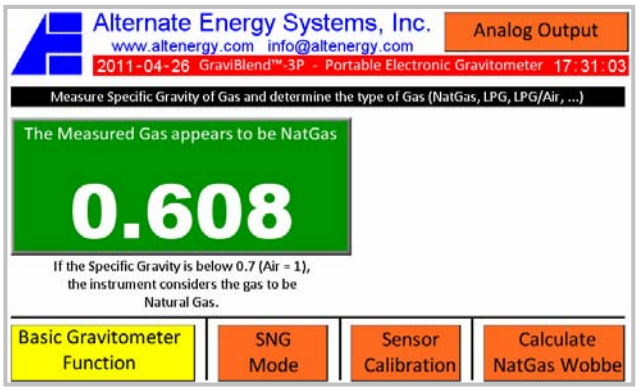
3. Operating Mode: Gravitometer with Advanced Features

Pressing the "Advanced Features" button on the startup screen changes the operating mode to "Gravitometer with Advanced Features", and opens the respective display.

The SG display on this screen can have four different background colors.

If the SG is below 0.7, the instrument interprets the gas as NatGas and shows the SG value on a green-colored background.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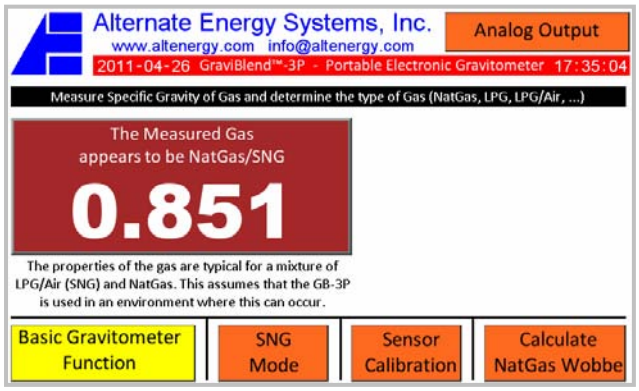
Analog Output
2011-04-26 GraviBlend™-3P - Portable Electronic Gravitometer 17:31:03
Measure Specific Gravity of Gas and determine the type of Gas (NatGas, LPG, LPG/Air, ...)
The Measured Gas appears to be NatGas
0.608
If the Specific Gravity is below 0.7 (Air = 1), the instrument considers the gas to be Natural Gas.
Basic Gravitometer Function
SNG Mode
Sensor Calibration
Calculate NatGas Wobbe

If the SG is between 0.7 and 1.25, the instrument interprets the gas as blend of NatGas and Synthetic Natural Gas (SNG) and shows the SG value on a brown-colored background.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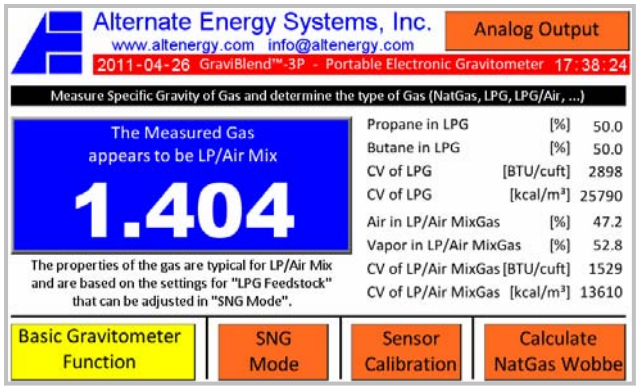
Analog Output
2011-04-26 GraviBlend™-3P - Portable Electronic Gravitometer 17:35:04
Measure Specific Gravity of Gas and determine the type of Gas (NatGas, LPG, LPG/Air, ...)
The Measured Gas appears to be NatGas/SNG
0.851
The properties of the gas are typical for a mixture of LPG/Air (SNG) and NatGas. This assumes that the GB-3P is used in an environment where this can occur.
Basic Gravitometer Function
SNG Mode
Sensor Calibration
Calculate NatGas Wobbe

If the SG is between 1.25 and 1.53, the instrument interprets the gas as LPG/Air blend (Synthetic Natural Gas; SNG) and shows the SG value on a blue-colored background.

In addition to the SG display, the screen also shows the properties of the LPG that is used in the SNG; the vapor/air blending ratio; and the Heating Value of the SNG.

NOTE:
The gas properties information is based on the LPG feedstock that has been selected while in Operating Mode SNG, or that was selected when 100% vapor was applied to the instrument (see below).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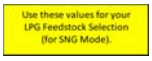
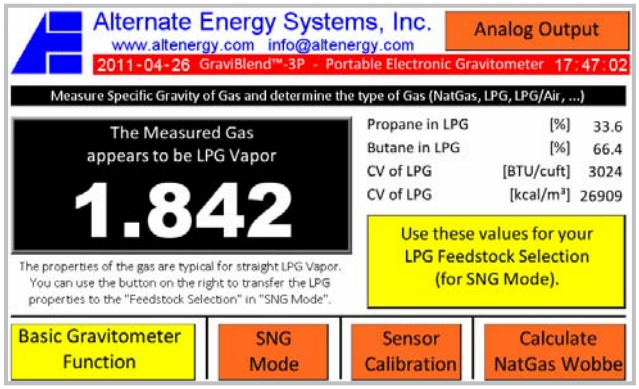
Analog Output
2011-04-26 GraviBlend™-3P - Portable Electronic Gravitometer 17:38:24
Measure Specific Gravity of Gas and determine the type of Gas (NatGas, LPG, LPG/Air, ...)
The Measured Gas appears to be LP/Air Mix
1.404
The properties of the gas are typical for LP/Air Mix and are based on the settings for "LPG Feedstock" that can be adjusted in "SNG Mode".
Propane in LPG [%] 50.0
Butane in LPG [%] 50.0
CV of LPG [BTU/cuft] 2898
CV of LPG [kcal/m³] 25790
Air in LP/Air MixGas [%] 47.2
Vapor in LP/Air MixGas [%] 52.8
CV of LP/Air MixGas [BTU/cuft] 1529
CV of LP/Air MixGas [kcal/m³] 13610
Basic Gravitometer Function
SNG Mode
Sensor Calibration
Calculate NatGas Wobbe

If the SG is above 1.53, the instrument interprets the gas as 100% LPG vapor and shows the SG value on a black-colored background.

In addition to the SG display, the screen also shows the Propane/Butane ratio in the LPG, and the Heating Value.



Press the yellow button to transfer the LPG properties to operating mode "Gravitometer for SNG Systems". This will allow the instrument to accurately calculate the properties of your SNG.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Analog Output
2011-04-26 GraviBlend™-3P - Portable Electronic Gravitometer 17:47:02
Measure Specific Gravity of Gas and determine the type of Gas (NatGas, LPG, LPG/Air, ...)
The Measured Gas appears to be LPG Vapor
1.842
The properties of the gas are typical for straight LPG Vapor. You can use the button on the right to transfer the LPG properties to the "Feedstock Selection" in "SNG Mode".
Propane in LPG [%] 33.6
Butane in LPG [%] 66.4
CV of LPG [BTU/cuft] 3024
CV of LPG [kcal/m³] 26909
Use these values for your LPG Feedstock Selection (for SNG Mode).
Basic Gravitometer Function
SNG Mode
Sensor Calibration
Calculate NatGas Wobbe

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3.1 Analog Output

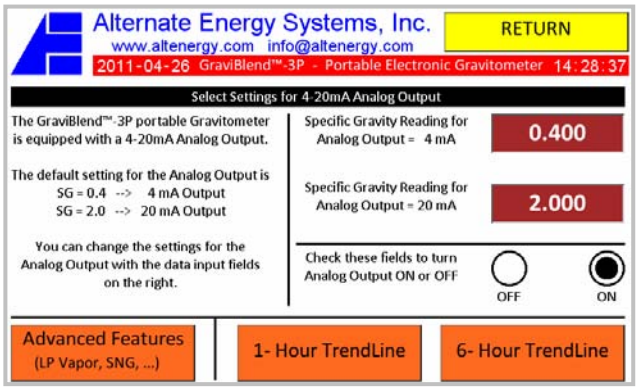
Analog Output

The GB-3P is equipped with an internally-powered 4-20 mA analog output. In operating mode "Gravitometer with Advanced Features", the output is assigned to represent the Specific Gravity. The output can be turned ON or OFF, and the range-assignment of the output can be established or changed, by pressing the "Analog Output" button in the upper-right area of this screen.

This opens the Analog Output Setup Screen. The screen has two numeric data input fields on the right, and two radio-buttons for ON/OFF below them.

In the example shown on the right, the Analog Output is set to 4mA at SG=0.4 and 20mA at SG=2.0.

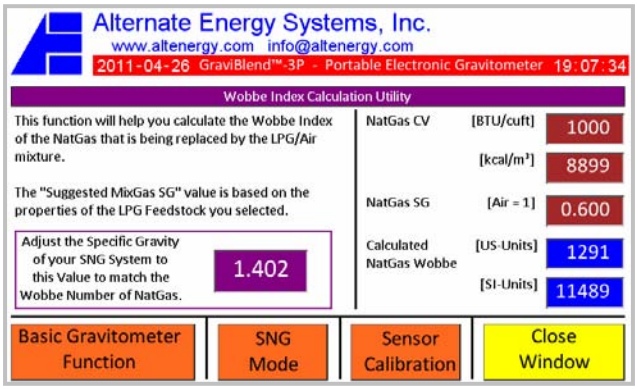
To change a setting, simply press the display field. This opens a 10-key keypad. Enter the new value and press ENTER.


Alternate Energy Systems, Inc.
www.altenergy.com info@altenergy.com
RETURN
2011-04-26 GraviBlend™-3P - Portable Electronic Gravitometer 14:28:37
Select Settings for 4-20mA Analog Output
The GraviBlend™-3P portable Gravitometer is equipped with a 4-20mA Analog Output.
The default setting for the Analog Output is
SG = 0.4 --> 4 mA Output
SG = 2.0 --> 20 mA Output
You can change the settings for the Analog Output with the data input fields on the right.
Specific Gravity Reading for Analog Output = 4 mA
0.400
Specific Gravity Reading for Analog Output = 20 mA
2.000
Check these fields to turn Analog Output ON or OFF
OFF
ON
Advanced Features (LP Vapor, SNG, ...)
1- Hour TrendLine
6- Hour TrendLine

3.2 Calculate Wobbe Index of Natural Gas

Calculate NatGas Wobbe

Pressing this button while in operating mode "Gravitometer with Advanced Features" opens a new screen that will help you calculate the Wobbe Index of any Hydrocarbon-based fuel gas (NatGas; BioGas; LandFill Gas; CokeOvenGas; etc.). This information will be helpful in determining the properties of a replacement gas, i.e. LP/Air.


Alternate Energy Systems, Inc.
www.altenergy.com info@altenergy.com
2011-04-26 GraviBlend™-3P - Portable Electronic Gravitometer 19:07:34
Wobbe Index Calculation Utility
This function will help you calculate the Wobbe Index of the NatGas that is being replaced by the LPG/Air mixture.
The "Suggested MixGas SG" value is based on the properties of the LPG Feedstock you selected.
Adjust the Specific Gravity of your SNG System to this Value to match the Wobbe Number of NatGas.
1.402
NatGas CV [BTU/cuft] 1000
[kcal/m³] 8899
NatGas SG [Air = 1] 0.600
Calculated NatGas Wobbe [US-Units] 1291
[SI-Units] 11489
Basic Gravitometer Function
SNG Mode
Sensor Calibration
Close Window

After entering the Calorific Value and the Specific Gravity of the to-be-replaced fuel gas, the instrument will calculate, and display, the Wobbe Index of the gas, and will also display the Specific Gravity of an LP-based replacement gas (in the lower-left of the screen).

In the example above, the CV of NatGas was entered as 1000 BTU/cuft (metric: 8899 kcal/m^3), and the SG as 0.600. The GB-3P calculated the Wobbe Index as 1291 (metric: 11489).

Based on the previously measured (see Section 3 on page 6) or entered (see Section 4 on page 9) properties of the available LPG, the instrument calculates, and displays, the properties of the LP/Air replacement gas in the in the lower-left of the screen.

In this example, the LP/Air blending system should be operated at a Vapor/Air setting that produces a MixGas Specific Gravity of 1.402.

NOTE:
The result of this calculation depends on the correct input of the LPG properties. Before calculating the SG of the replacement LPG/Air gas, the properties of the LPG feedstock must be entered (see section 3 on page 6, and Section 4 on page 9).

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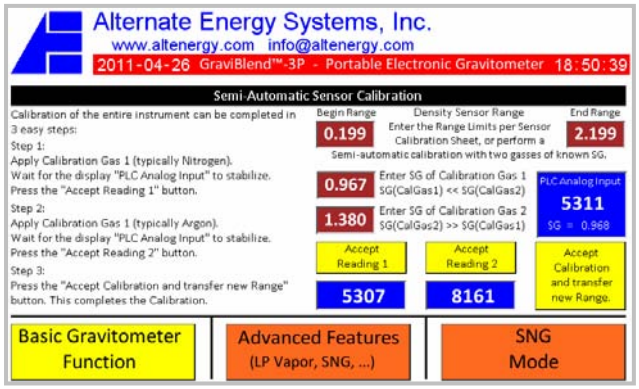
3.3 Semi-Automatic Calibration Procedure

Calibrating gravitometers has always been a big problem, usually requiring that the instrument be returned to the manufacturer.

Alternate Energy Systems has developed a method that provides for a simple-yet-powerful routine that recalibrates the entire system in only a few steps.

Because the calibration procedure includes the entire system (from density cell to signal converter to PLC input), the overall system accuracy will be greatly improved.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2011-04-26 GraviBlend™-3P - Portable Electronic Gravitometer 18:50:39
Semi-Automatic Sensor Calibration
Calibration of the entire instrument can be completed in 3 easy steps:
Step 1:
Apply Calibration Gas 1 (typically Nitrogen).
Wait for the display "PLC Analog Input" to stabilize.
Press the "Accept Reading 1" button.
Step 2:
Apply Calibration Gas 1 (typically Argon).
Wait for the display "PLC Analog Input" to stabilize.
Press the "Accept Reading 2" button.
Step 3:
Press the "Accept Calibration and transfer new Range" button. This completes the Calibration.
Begin Range
0.199
Density Sensor Range
Enter the Range Limits per Sensor Calibration Sheet, or perform a Semi-automatic calibration with two gasses of known SG.
End Range
2.199
0.967
Enter SG of Calibration Gas 1
SG(CalGas1) << SG(CalGas2)
1.380
Enter SG of Calibration Gas 2
SG(CalGas2) >> SG(CalGas1)
PLC Analog Input
5311
SG = 0.968
Accept Reading 1
Accept Reading 2
Accept Calibration and transfer new Range.
5307
8161
Basic Gravitometer Function
Advanced Features (LP Vapor, SNG, ...)
SNG Mode

Follow these simple steps to calibrate the gravitometer:

a) Select the Reference Gasses
The two calibration gasses should have specific gravities that are close to the upper and lower limits of the expected measurement range, respectively. If used with LPG/air mixtures, two commonly available gasses would be Nitrogen (N_2; SG=0.967) and Argon (Ar; SG=1.38).

b) Enter the Specific Gravity of the two Calibration Gasses
Enter the specific gravities of the two selected gasses in the numeric data entry fields labeled “Enter SG of Calibration Gas 1” and “Enter SG of Calibration Gas 2”. The value for the gas with the lower SG must be entered in field “Enter SG of Calibration Gas 1”.

c) Apply Calibration Gas 1
Connect the first calibration gas to the Gravitometer.

d) Accept Reading 1
After the display “PLC Analog Input” has stabilized, press the “Accept Reading 1” button. The display field below this button will now show the “raw” data at the PLC analog input.

e) Apply Calibration Gas 2
Connect the second calibration gas to the Gravitometer.

f) Accept Reading 2
After the display “PLC Analog Input” has stabilized, press the “Accept Reading 2” button. The display field below this button will now show the “raw” data at the PLC analog input.

g) Transfer Calibration Data
After completing step f), press the “Accept Calibration and transfer new Range” button. This will cause the PLC to calculate the new range of the density cell, optimized for the section represented by the two calibration gasses. The new Sensor Range is shown in the two numeric display fields in the upper section of the window.

This completes the calibration procedure.

NOTE:
You can also set the range of the density cell by manually entering the data in the numeric display fields labeled “Begin Range” and “End Range”.

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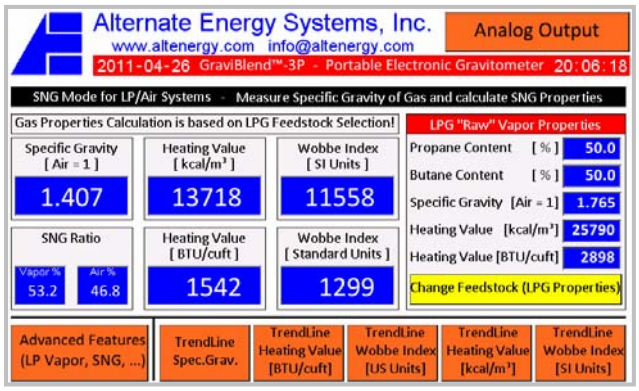
4. Operating Mode: Gravitometer for SNG Systems

SNG Mode

Pressing the button labeled "SNG Mode" selects the Gravitometer function that was specifically designed for LP/Air Systems.


Alternate Energy Systems, Inc.
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Analog Output
2011-04-26 GraviBlend™-3P - Portable Electronic Gravitometer 20:06:18
SNG Mode for LP/Air Systems - Measure Specific Gravity of Gas and calculate SNG Properties
Gas Properties Calculation is based on LPG Feedstock Selection!
Specific Gravity [Air = 1]
1.407
Heating Value [kcal/m³]
13718
Wobbe Index [SI Units]
11558
SNG Ratio
Vapor %
53.2
Air %
46.8
Heating Value [BTU/cuft]
1542
Wobbe Index [Standard Units]
1299
LPG "Raw" Vapor Properties
Propane Content [%] 50.0
Butane Content [%] 50.0
Specific Gravity [Air = 1] 1.765
Heating Value [kcal/m³] 25790
Heating Value [BTU/cuft] 2898
Change Feedstock (LPG Properties)
Advanced Features (LP Vapor, SNG, ...)
TrendLine Spec.Grav.
TrendLine Heating Value [BTU/cuft]
TrendLine Wobbe Index [US Units]
TrendLine Heating Value [kcal/m³]
TrendLine Wobbe Index [SI Units]

Pressing the button labeled "SNG Mode" selects the Gravitometer function that was specifically designed for LP/Air Systems.

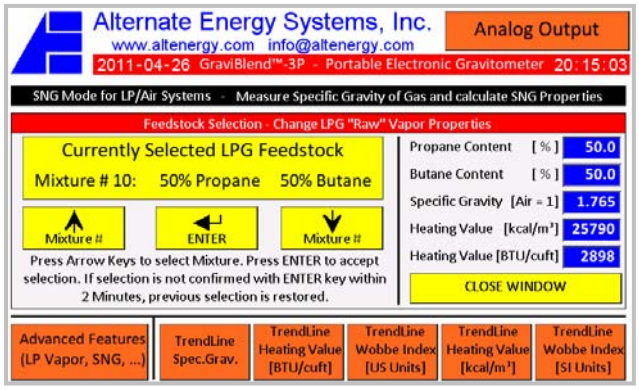
The screen displays the measured Specific Gravity of the LP/Air Mix, and the calculated Calorific Value and Wobbe Index, in both standard US engineering units (BTU/cuft) and in metric SI units (kcal/m^3). Also shown is the SNG Ratio (Vapor % / Air %).

The accuracy of the Calorific Value and Wobbe Index calculations is based on entering the correct information about the LPG feedstock that is used to generate the replacement gas (Synthetic Natural Gas, SNG).

Change Feedstock (LPG Properties)

The panel on the far-right of the screen (labeled "LPG 'Raw' Vapor Properties") shows the properties of the currently selected LPG feedstock. To change the selection, press the yellow button labeled "Change Feedstock (LPG Properties)" at the bottom of this panel.

4.1 Change LPG Feedstock Properties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Analog Output
2011-04-26 GraviBlend™-3P - Portable Electronic Gravitometer 20:15:03
SNG Mode for LP/Air Systems - Measure Specific Gravity of Gas and calculate SNG Properties
Feedstock Selection - Change LPG "Raw" Vapor Properties
Currently Selected LPG Feedstock
Mixture # 10: 50% Propane 50% Butane
Mixture #
ENTER
Mixture #
Press Arrow Keys to select Mixture. Press ENTER to accept selection. If selection is not confirmed with ENTER key within 2 Minutes, previous selection is restored.
Propane Content [%] 50.0
Butane Content [%] 50.0
Specific Gravity [Air = 1] 1.765
Heating Value [kcal/m³] 25790
Heating Value [BTU/cuft] 2898
CLOSE WINDOW
Advanced Features (LP Vapor, SNG, ...)
TrendLine Spec.Grav.
TrendLine Heating Value [BTU/cuft]
TrendLine Wobbe Index [US Units]
TrendLine Heating Value [kcal/m³]
TrendLine Wobbe Index [SI Units]

Gravitometers measure the specific gravity of the MixedGas. Other information about the gas (such as Calorific Value or Wobbe Index) can be calculated from the SG, if the properties of the LPG feedstock are known.

This instrument makes it easy to select the LPG feedstock properties from a list of 20 pre-defined mixtures; or to enter the Propane/Butane composition of the LPG; or to enter the SG and CV of the "raw" LPG vapor.

The panel on the far-right of the screen (labeled "LPG 'Raw' Vapor Properties") shows the properties of the currently selected LPG feedstock.

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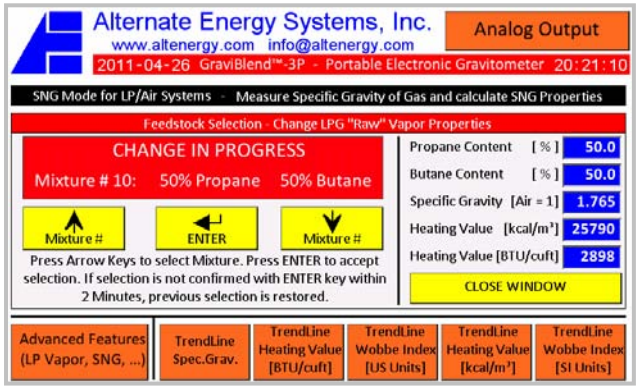
4.1.1 Select Pre-Defined Mixture


Alternate Energy Systems, Inc.
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Analog Output
2011-04-26 GraviBlend™-3P - Portable Electronic Gravitometer 20:21:10
SNG Mode for LP/Air Systems - Measure Specific Gravity of Gas and calculate SNG Properties
Feedstock Selection - Change LPG "Raw" Vapor Properties
CHANGE IN PROGRESS
Mixture # 10: 50% Propane 50% Butane
Mixture #
ENTER
Mixture #
Press Arrow Keys to select Mixture. Press ENTER to accept selection. If selection is not confirmed with ENTER key within 2 Minutes, previous selection is restored.
Propane Content [%] 50.0
Butane Content [%] 50.0
Specific Gravity [Air = 1] 1.765
Heating Value [kcal/m³] 25790
Heating Value [BTU/cuft] 2898
CLOSE WINDOW
Advanced Features (LP Vapor, SNG, ...)
TrendLine Spec.Grav.
TrendLine Heating Value [BTU/cuft]
TrendLine Wobbe Index [US Units]
TrendLine Heating Value [kcal/m³]
TrendLine Wobbe Index [SI Units]

To select a different pre-defined LPG mixture, press the “Arrow-UP” or “Arrow-DOWN” button. The “Arrow-UP” button selects LPG Feedstock with lower Butane content; the “Arrow-DOWN” button selects LPG Feedstock with lower Butane content.

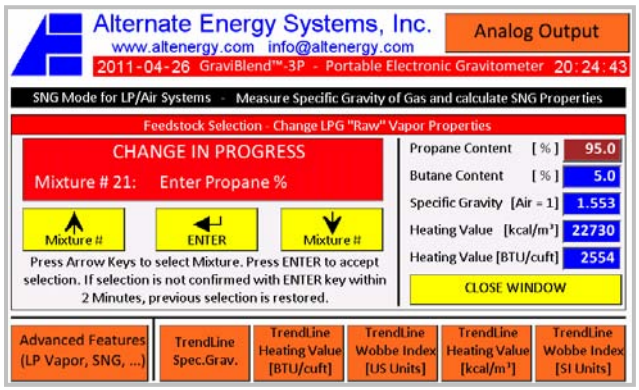
After the first pressing of an Arrow button, the background color of the display changes to “red”, reminding you that a new Feedstock has not yet been selected.

Once you have found the proper display of Propane and Butane content, press the ENTER key.

List of pre-defined LPG mixtures.

Input SG + CV		Input Propane %		HD-5 LPG			
95%	Prop	5%	But	55%	Prop	45%	But
90%	Prop	10%	But	50%	Prop	50%	But
85%	Prop	15%	But	45%	Prop	55%	But
80%	Prop	20%	But	40%	Prop	60%	But
75%	Prop	25%	But	35%	Prop	65%	But
70%	Prop	30%	But	30%	Prop	70%	But
65%	Prop	35%	But	25%	Prop	75%	But
60%	Prop	40%	But	20%	Prop	80%	But
				15%	Prop	85%	But
				10%	Prop	90%	But
				5%	Prop	95%	But

4.1.2 Enter Propane-Percentage


Alternate Energy Systems, Inc.
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Analog Output
2011-04-26 GraviBlend™-3P - Portable Electronic Gravitometer 20:24:43
SNG Mode for LP/Air Systems - Measure Specific Gravity of Gas and calculate SNG Properties
Feedstock Selection - Change LPG "Raw" Vapor Properties
CHANGE IN PROGRESS
Mixture # 21: Enter Propane %
Mixture #
ENTER
Mixture #
Press Arrow Keys to select Mixture. Press ENTER to accept selection. If selection is not confirmed with ENTER key within 2 Minutes, previous selection is restored.
Propane Content [%] 95.0
Butane Content [%] 5.0
Specific Gravity [Air = 1] 1.553
Heating Value [kcal/m³] 22730
Heating Value [BTU/cuft] 2554
CLOSE WINDOW
Advanced Features (LP Vapor, SNG, ...)
TrendLine Spec.Grav.
TrendLine Heating Value [BTU/cuft]
TrendLine Wobbe Index [US Units]
TrendLine Heating Value [kcal/m³]
TrendLine Wobbe Index [SI Units]

If there is no pre-defined LPG mixture close enough to your feedstock properties, use the Arrow keys until the display shows “Enter Propane %”, then press the ENTER key.

You can now press the display field “Propane %” and enter the Propane-percentage of your LPG.

The Butane-percentage is calculated automatically by the system.

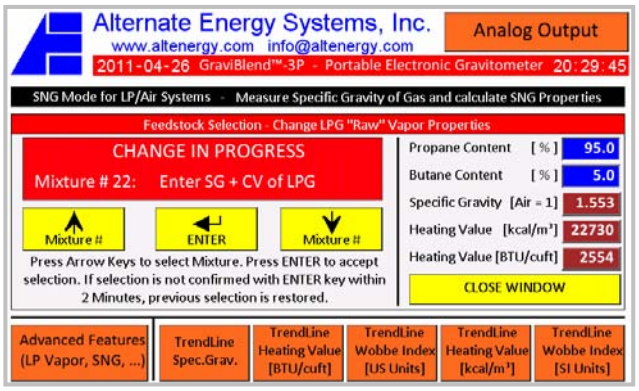
To indicate that a numeric display field is ready to accept a user input, it changes its background color to dark-red.

NOTE:
Although your LPG mixture may contain other components besides Propane and Butane, it is only required to enter the Propane percentage. The remaining volume is assumed to be Butane. If other LPGs are present in the mixture, they are usually minor contributors, and their specific gravities and calorific values are typically so close to the properties of Butane, that the overall accuracy is not negatively affected. If you feel that the resulting LPG properties are not accurate enough, use the procedure in the next section to enter more accurate data for your specific LPG.

4.1.3 Enter Feedstock CV and SG

If Calorific Value and Specific Gravity of the "raw" LPG vapor are known, use the Arrow keys until the display shows "Enter SG + CV of LPG", then press the ENTER key.

You can now press the display fields "Specific Gravity" and "BTU/cuft" or "kcal/m³" to enter the Calorific Value and the Specific Gravity of your LPG.


Alternate Energy Systems, Inc.
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Analog Output
2011-04-26 GraviBlend™-3P - Portable Electronic Gravitometer 20:29:45
SNG Mode for LP/Air Systems - Measure Specific Gravity of Gas and calculate SNG Properties
Feedstock Selection - Change LPG "Raw" Vapor Properties
CHANGE IN PROGRESS
Mixture # 22: Enter SG + CV of LPG
Mixture #
ENTER
Mixture #
Press Arrow Keys to select Mixture. Press ENTER to accept selection. If selection is not confirmed with ENTER key within 2 Minutes, previous selection is restored.
Propane Content [%] 95.0
Butane Content [%] 5.0
Specific Gravity [Air = 1] 1.553
Heating Value [kcal/m³] 22730
Heating Value [BTU/cuft] 2554
CLOSE WINDOW
Advanced Features (LP Vapor, SNG, ...)
TrendLine Spec.Grav.
TrendLine Heating Value [BTU/cuft]
TrendLine Wobbe Index [US Units]
TrendLine Heating Value [kcal/m³]
TrendLine Wobbe Index [SI Units]

NOTE:
After entering the new Feedstock properties, the Propane and Butane percentages will be re-calculated and displayed. The calculation is again (see above) based on the assumption that the LPG consists only of Propane and Butane.

NOTE:
If the ENTER key is not pressed within 2 minutes, the Feedstock Selection reverts back to the previous setting.

4.2 Analog Output in Operating Mode "SNG"

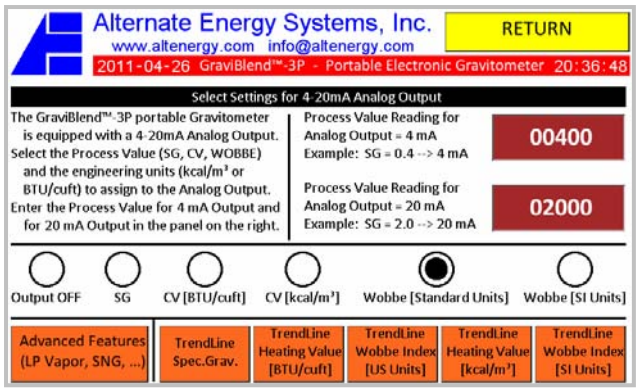
Analog Output

The GB-3P is equipped with an internally-powered 4-20 mA analog output. In operating mode "Gravitometer for SNG Systems", the output can be assigned to represent Specific Gravity, Heating Value, or Wobbe Index by pressing one of the radio buttons across the bottom of the screen.

The range-assignment of the output can be established, or changed, by entering the new assignments into the numeric display fields in the center-right of the screen.

In the example shown on the right, the Analog Output is set to 4mA at Wobbe Index = 400 and 20mA at Wobbe Index = 2000.

To change a setting, simply press the display field and follow the procedure described in Section 2.1.1 on page 5.


Alternate Energy Systems, Inc.
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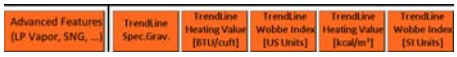
RETURN
2011-04-26 GraviBlend™-3P - Portable Electronic Gravitometer 20:36:48
Select Settings for 4-20mA Analog Output
The GraviBlend™-3P portable Gravitometer is equipped with a 4-20mA Analog Output. Select the Process Value (SG, CV, WOBBE) and the engineering units (kcal/m³ or BTU/cuft) to assign to the Analog Output. Enter the Process Value for 4 mA Output and for 20 mA Output in the panel on the right.
Process Value Reading for Analog Output = 4 mA
Example: SG = 0.4 --> 4 mA
00400
Process Value Reading for Analog Output = 20 mA
Example: SG = 2.0 --> 20 mA
02000
Output OFF
SG
CV [BTU/cuft]
CV [kcal/m³]
Wobbe [Standard Units]
Wobbe [SI Units]
Advanced Features (LP Vapor, SNG, ...)
TrendLine Spec.Grav.
TrendLine Heating Value [BTU/cuft]
TrendLine Wobbe Index [US Units]
TrendLine Heating Value [kcal/m³]
TrendLine Wobbe Index [SI Units]

GraviBlend-3P_Manual_Generic_12Apr12.doc Printed 4/13/2012 7:22:00 AM

4.3 TrendLine Recording in Operating Mode "SNG"

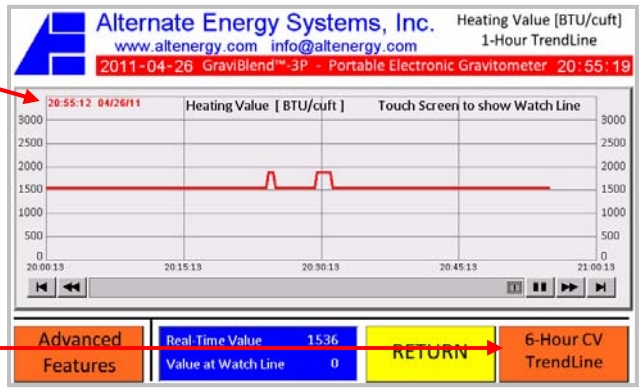
When in "SNG" mode, the system monitors the values for Specific Gravity, Heating Value, and Wobbe Index. The data is stored every 15 seconds in one datalog file for standard US units, and a separate datalog file for SI units.

The stored data can be recalled and graphically displayed by pressing one of the five buttons across the bottom of the screen.

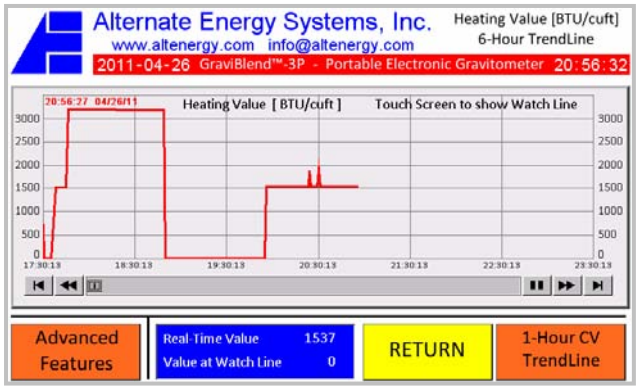

Advanced Features (LP Vapor, SNG, ...)
TrendLine Spec.Grav.
TrendLine Heating Value [BTU/cuft]
TrendLine Wobbe Index [US Units]
TrendLine Heating Value [kcal/m³]
TrendLine Wobbe Index [SI Units]

The bottom of the TrendLine Display has a time stamp. Current Time and Date are also shown in the upper-left area of the graphic.

The time scale of the TrendLine can be switched from 1-hour to 6-hours by pressing the button in the bottom-right of the screen.



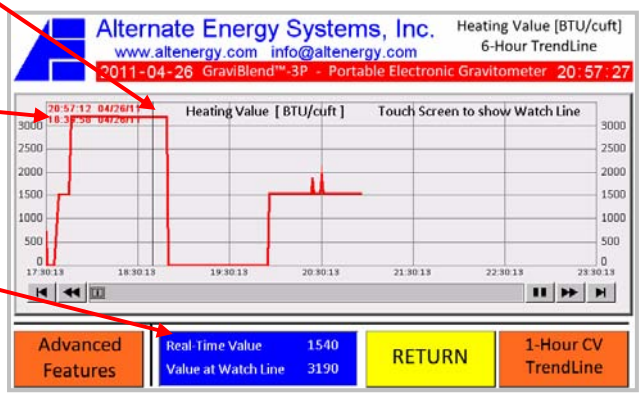
NOTE:
All data log values are also stored on a Secure Data card (SD card) that is inserted into the EOI. The SD card holds two years worth of data. The data can be read by Microsoft Excel with the data viewer that is included on the SD card. See Appendix D for details.



If you touch the screen anywhere in the TrendLine Display, a vertical line appears.

The Time and Date of the position of the vertical line are displayed below the realtime Time and Date display.

The process values that were recorded at that time and date are shown in the lower-center area of the screen.



NOTE:
You can navigate the trend line graphics with the scroll buttons at the bottom of the screen.

NOTE:
The EOI stores up to 96 hours of data. After 96 hours of data are recorded, the oldest data is discarded and replaced by newer data.

Appendix A List of Selectable LPG Mixtures

	Propane	Butane			
BTU/cuft	2516	3280			
S.G.	1.53	2.00			
Mixture #	Propane Percentage	Butane Percentage	Calorific Value BTU/cuft	Calorific Value kcal/m^3	Specific Gravity
0	100%	0%	2516	22390	1.530
1	95%	5%	2554	22728	1.554
2	90%	10%	2592	23067	1.577
3	85%	15%	2631	23414	1.600
4	80%	20%	2669	23752	1.624
5	75%	25%	2707	24090	1.647
6	70%	30%	2745	24428	1.671
7	65%	35%	2783	24766	1.694
8	60%	40%	2822	25113	1.718
9	55%	45%	2860	25452	1.741
10	50%	50%	2898	25790	1.765
11	45%	55%	2936	26128	1.788
12	40%	60%	2974	26466	1.812
13	35%	65%	3013	26813	1.835
14	30%	70%	3051	27151	1.859
15	25%	75%	3089	27489	1.882
16	20%	80%	3127	27828	1.906
17	15%	85%	3165	28166	1.929
18	10%	90%	3127	28513	1.953
19	5%	85%	3242	28851	1.976

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Appendix B Calculation of Mixed Gas Composition based on S.G. reading and Feedstock Properties

The following formula can be used to calculate the vapor/air composition of the mixed gas. The two tables below show the results of the calculation for two different feedstock properties (HD-5, 95% propane, 5% butane, and a typical butane propane mixture with 70% butane and 30% propane).

$$\text{Vapor Volume [\%]} = \frac{1 - SG_{\text{mixed gas}}}{1 - SG_{\text{raw vapor}}} \times 100$$

Prop %	But %	S.G.	C.V.	Wobbe
95%	5%	1.554	2554	2049

LPG %	Air %	S.G.	C.V.	Wobbe
27.10%	72.9%	1.15	692	645
28.91%	71.1%	1.16	738	686
30.71%	69.3%	1.17	784	725
32.52%	67.5%	1.18	831	765
34.33%	65.7%	1.19	877	804
36.13%	63.9%	1.20	923	843
37.94%	62.1%	1.21	969	881
39.75%	60.3%	1.22	1015	919
41.55%	58.4%	1.23	1061	957
43.36%	56.6%	1.24	1108	995
45.17%	54.8%	1.25	1154	1032
46.97%	53.0%	1.26	1200	1069
48.78%	51.2%	1.27	1246	1106
50.59%	49.4%	1.28	1292	1142
52.39%	47.6%	1.29	1338	1178
54.20%	45.8%	1.30	1384	1214
56.01%	44.0%	1.31	1431	1250
57.81%	42.2%	1.32	1477	1285
59.62%	40.4%	1.33	1523	1320
61.43%	38.6%	1.34	1569	1355
63.23%	36.8%	1.35	1615	1390
65.04%	35.0%	1.36	1661	1425
66.85%	33.2%	1.37	1707	1459
68.65%	31.3%	1.38	1754	1493
70.46%	29.5%	1.39	1800	1526
72.27%	27.7%	1.40	1846	1560
74.07%	25.9%	1.41	1892	1593
75.88%	24.1%	1.42	1938	1626
77.69%	22.3%	1.43	1984	1659
79.49%	20.5%	1.44	2030	1692
81.30%	18.7%	1.45	2077	1725
83.11%	16.9%	1.46	2123	1757
84.91%	15.1%	1.47	2169	1789
86.72%	13.3%	1.48	2215	1821
88.53%	11.5%	1.49	2261	1852
90.33%	9.7%	1.50	2307	1884

Prop %	But %	S.G.	C.V.	Wobbe
30%	70%	1.859	3051	2238

LPG %	Air %	S.G.	C.V.	Wobbe
34.92%	65.1%	1.30	1065	934
36.09%	63.9%	1.31	1101	962
37.25%	62.7%	1.32	1137	989
38.42%	61.6%	1.33	1172	1016
39.58%	60.4%	1.34	1208	1043
40.75%	59.3%	1.35	1243	1070
41.91%	58.1%	1.36	1279	1096
43.07%	56.9%	1.37	1314	1123
44.24%	55.8%	1.38	1350	1149
45.40%	54.6%	1.39	1385	1175
46.57%	53.4%	1.40	1421	1201
47.73%	52.3%	1.41	1456	1226
48.89%	51.1%	1.42	1492	1252
50.06%	49.9%	1.43	1527	1277
51.22%	48.8%	1.44	1563	1302
52.39%	47.6%	1.45	1598	1327
53.55%	46.4%	1.46	1634	1352
54.71%	45.3%	1.47	1669	1377
55.88%	44.1%	1.48	1705	1401
57.04%	43.0%	1.49	1740	1426
58.21%	41.8%	1.50	1776	1450
59.37%	40.6%	1.51	1811	1474
60.54%	39.5%	1.52	1847	1498
61.70%	38.3%	1.53	1882	1522
62.86%	37.1%	1.54	1918	1545
64.03%	36.0%	1.55	1953	1569
65.19%	34.8%	1.56	1989	1592
66.36%	33.6%	1.57	2024	1616
67.52%	32.5%	1.58	2060	1639
68.68%	31.3%	1.59	2095	1662
69.85%	30.2%	1.60	2131	1685
71.01%	29.0%	1.61	2166	1707
72.18%	27.8%	1.62	2202	1730
73.34%	26.7%	1.63	2237	1753
74.51%	25.5%	1.64	2273	1775
75.67%	24.3%	1.65	2309	1797

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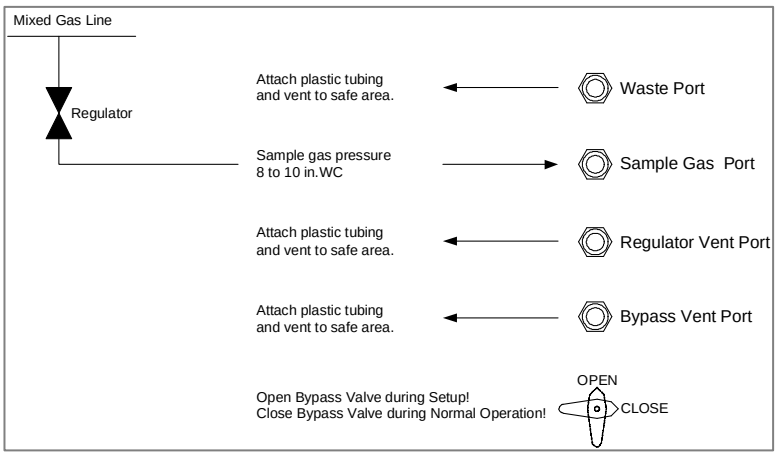
Appendix C Connection to the Sample Gas Source

C1 Waste Port

After passing through the density cell, the sample gas exits at the "Waste Port". Connect (plastic) tubing to this port and vent the gas to a safe are.


Mixed Gas Line
Regulator
Attach plastic tubing and vent to safe area.
Waste Port
Sample gas pressure 8 to 10 in.WC
Sample Gas Port
Attach plastic tubing and vent to safe area.
Regulator Vent Port
Attach plastic tubing and vent to safe area.
Bypass Vent Port
Open Bypass Valve during Setup!
Close Bypass Valve during Normal Operation!
OPEN
CLOSE

C2 Sample Gas Port

Sample gas from the mixed gas line is connected to the "Sample Gas Port". The pressure of the sample gas must be reduced to 8 to 12 in. WC by using a standard regulator, for example a REGO model LV404B23.

C3 Regulator Vent Port

The vent line of the internal pressure regulator is connected to the "Regulator Vent Port". Connect (plastic) tubing to this port and vent the gas to a safe are.

C4 Bypass Valve and Bypass Vent Port

To increase flow of fresh sample gas to the gravitometer, the Bypass Valve can be opened. The excess gas is vented through the Bypass Vent Port. Connect (plastic) tubing to this port and vent the gas to a safe are.

C5 Internal Regulator Setting

Open the gold-colored instrument cover by turning the two silver-colored latches counter-clockwise and lifting the cover upward. A Fisher regulator with adjustable range 0 to 5 in. WC is connected between the sample gas inlet and the density cell.

With sample gas connected to the GraviBlend®, adjust the regulator (if necessary) until the pressure gauge on the right side in the instrument cover reads approximately 1.5 to 2 in. WC.

C6 Function of the pressure gauge on the left side in the instrument cover

The gauge on the left side in the instrument cover is a differential pressure gauge, indicating the differential pressure across the Gas Consumption Jet (see schematics on next page).

Under normal operating conditions, the differential pressure will be approximately the same as the system pressure as indicated by the pressure gauge on the right.

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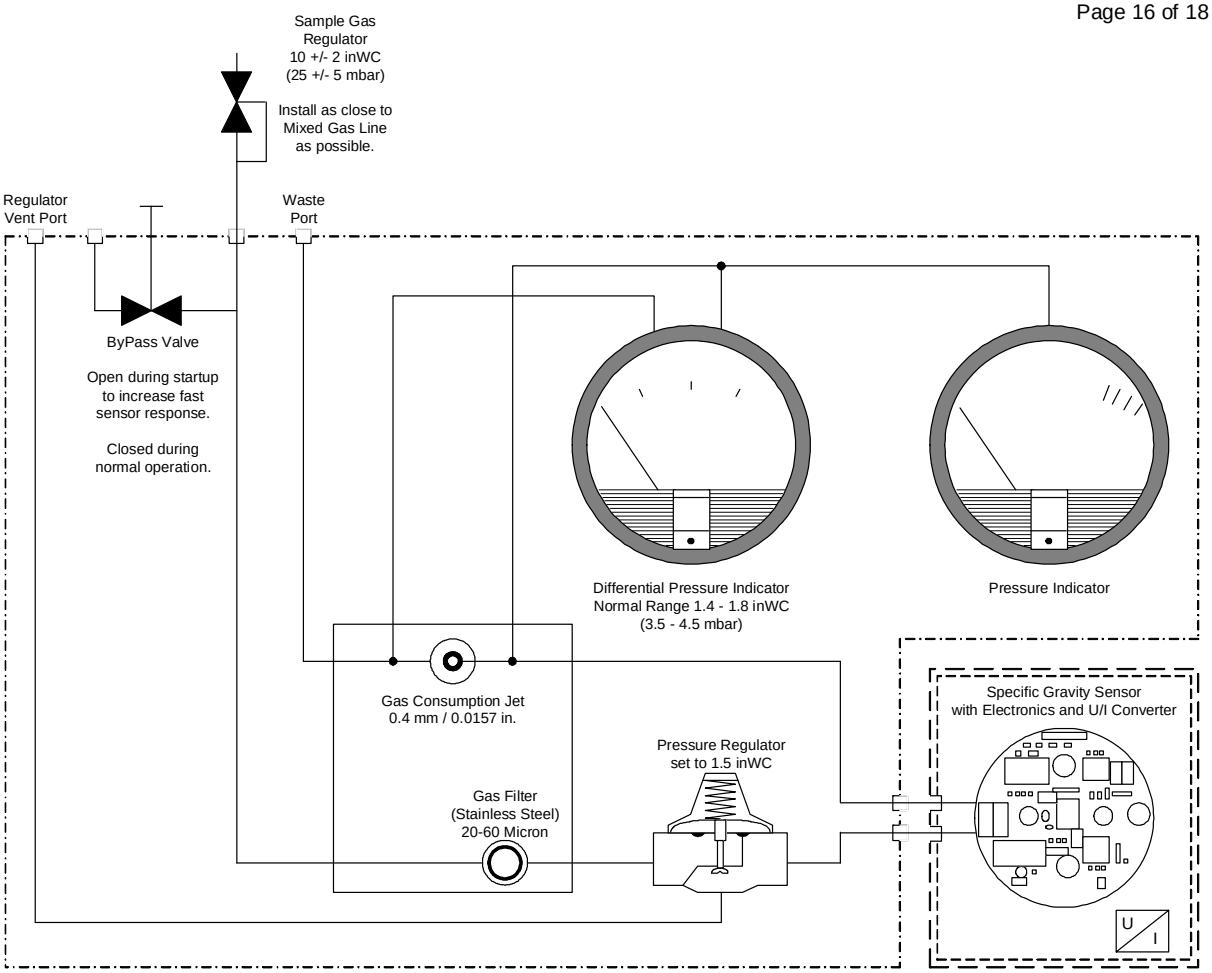


If the differential pressure is substantially less than the system pressure, check the Waste Port for blockage.

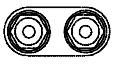
If this does not solve the problem, remove the screw cap above the Gas Consumption Jet, remove the orifice, and clean it.

C7 Stainless Steel Gas Filter

The multi-function manifold block inside the GraviBlend® enclosure features an integrated stainless steel micro filter. This filter is intended to remove solid objects from the sample gas stream, without significantly reducing the gas flow.

If the system pressure cannot be adjusted through the internal pressure regulator to the recommended 1.5 to 2 in. WC, check the correct supply pressure in the sample gas line. If this does not solve the problem, remove the screw cap above the Stainless Steel Gas Filter, remove the filter element, and clean or replace it.

C8 Analog Output 4 to 20 mA (Option)



If so equipped, the red and black terminals to the left of the operator interface provide a scaled analog output signal in the range of 4 to 20 mA. Depending on the selected Operating Mode, the output can be assigned to Specific Gravity, Heating Value, or Wobbe Index.

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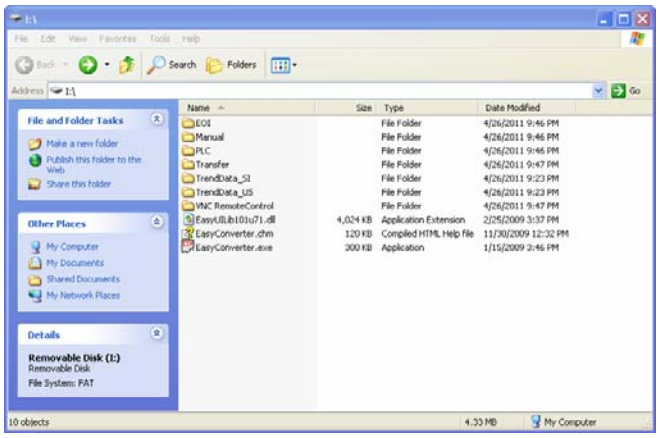
Appendix D Micro SD Card Structure

This Electronic Operator Interface (EOI) has a slot for a Micro SD Card. The main function of this card is to store the data log files (see Section 4.3 on page 12). The data is stored in two directories named "TrendData_SI" and "TrendData_US".

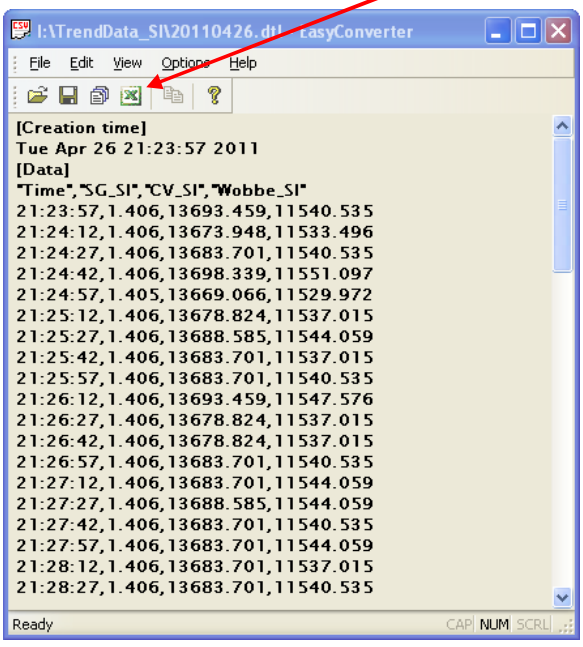


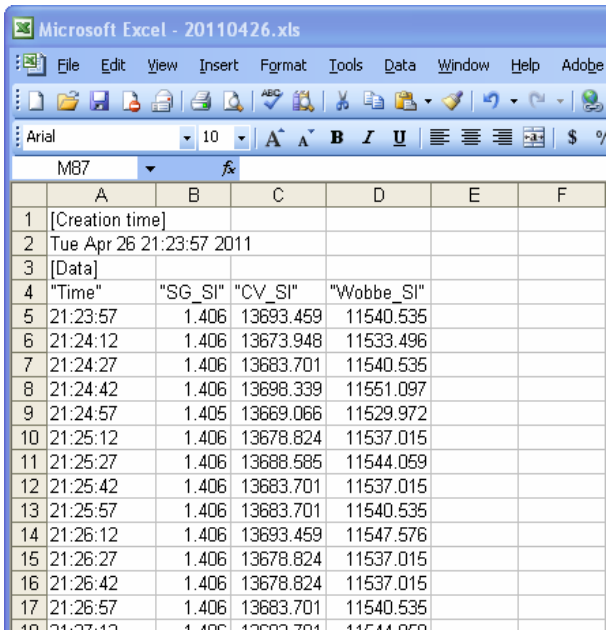
The SD card also holds a PDF version of this manual in the directory "Manual", copies of the PLC program and the EOI program, the remote access client software (in directory "VNC Remote Control"), and the converter program to access the stored data log files "EasyConverter.exe".

You can run the converter program to access the stored data log files by simply double-clicking on it. Open a data log file by clicking File – Open… and then selecting one of the files on the card.

The data log file names consist of 8 numbers, and the file extension ".dtl". The 8 numbers of the file name represent the date when the data was recorded (for example 20110426.dtl contains the data log for April 26, 2011).

You can review the data on the screen, or convert the data to an Excel file for further processing. To convert a dtl file, simply press the Excel icon below the title bar of the EasyConverter application.





	A	B	C	D	E	F
1	[Creation time]					
2	Tue Apr 26 21:23:57 2011					
3	[Data]					
4	"Time"	"SG_SI"	"CV_SI"	"Wobbe_SI"		
5	21:23:57	1.406	13693.459	11540.535		
6	21:24:12	1.406	13673.948	11533.496		
7	21:24:27	1.406	13683.701	11540.535		
8	21:24:42	1.406	13698.339	11551.097		
9	21:24:57	1.405	13669.066	11529.972		
10	21:25:12	1.406	13678.824	11537.015		
11	21:25:27	1.406	13688.585	11544.059		
12	21:25:42	1.406	13683.701	11537.015		
13	21:25:57	1.406	13683.701	11540.535		
14	21:26:12	1.406	13693.459	11547.576		
15	21:26:27	1.406	13678.824	11537.015		
16	21:26:42	1.406	13678.824	11537.015		
17	21:26:57	1.406	13683.701	11540.535		

NOTE: Specific Gravity, Heating Value, and Wobbe Index are logged every 15 seconds. This results in a total of 5760 data sets per day (= 5760 data sets per dtl file). Since the SD card stores dtl files for 2 years (731 days), it will hold 731 x 5760 = 4,210,560 data sets.

Alternate Energy Systems, Inc. • 210 Prospect Park • Peachtree City, GA 30269, USA
Phone (770) 487-8596 • Fax (770) 631-4306 • e-mail: info@altenergy.com • http://www.altenergy.com

Appendix E Remote Access

The operator interface is equipped with a remote access feature. You can access the panel with a "VNC Viewer" via its Ethernet port.

The VNC Viewer is freeware and is included on the SD card (see above). You can install the VNC viewer on as many PCs or Laptops as you like.

The VNC Viewer accesses the panel via Port 5900. If the panel is located behind a router or a firewall, make certain that this port is open, and that port forwarding for this port is pointed to the IP address of the panel. The default (local) IP address of the panel is 192.168.000.34.

After launching the VNC Viewer, a connection window appears. Enter the IP address of the EOI, or the IP address of the router that is in front of the EOI, and click the "Connect" button.

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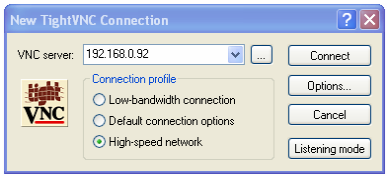
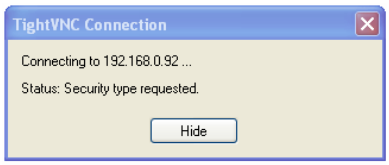
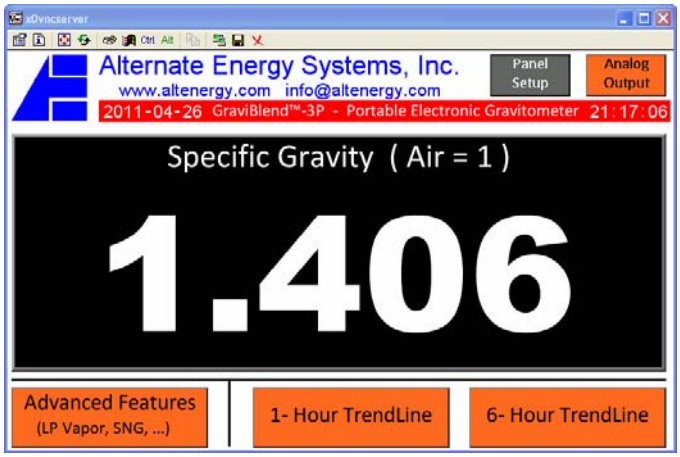




When the connection is established, a login window appears. Enter the default password "111111" and click the "OK" button.

The screen that is currently displayed at the EOI appears in a new window on your PC screen. You can now operate the GB-3P as if you were physically in front of it.



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